Appendix A: HEP Case Histories

Case 1: Salem Nuclear Generating Station

Background

PSE&G operates the Salem Nuclear Generating Station in Lower Alloway Township, Salem County, New Jersey, that withdraws once-through cooling water from Delaware Bay pursuant to an NPDES permit issued by the New Jersey Department of Environmental Protection (NJDEP). The NPDES permit for Salem was most recently renewed on July 29, 2001. While the Salem Generating Station operates on a vastly greater scale than the MBPP (Salem has a generating capacity of 2,300 MW and withdraws up to 3.02 billion gallons of cooling water per day), Salem's wetlands restoration program is predicated on the very same scientific principles that underlie Duke's HEP for Morro Bay. These principles are described in detail in Section 4 of this submittal, Habitat Equivalency Analysis.

Overview of Required Mitigation

In the 1994 NPDES permit for the Salem plant, NJDEP required PSE&G to undertake an extensive wetlands restoration and enhancement program to further minimize environmental impacts from the Station's cooling water intake structure. Collectively with other technological improvements, these conditions were determined to adequately minimize the effects of Station-related operations, consistent with the requirements of section 316(b) of the Clean Water Act.

In response to the wetlands restoration requirements of the 1994 permit, PSE&G established the Estuary Enhancement Program (EEP). The EEP has acquired, preserved or restored a significant amount of acreage in and around the Delaware Estuary (over 20,000 acres have been restored, acquired and/or preserved with 10,549 of that creditable towards the permit requirements). PSE&G's wetlands restoration program was carried forward in the 2001 permit (Special Condition 3).

The wetlands restoration program is an important component in minimizing entrainment and impingement effects, especially as it relates to restoration of fish populations. Temperate zone tidal saltmarshes, such as those fringing the Delaware Bay and Estuary, consist of a unique assemblage of plants and animals, and their connecting estuaries are among the most productive ecosystems. An increase in the wetlands in the Delaware Estuary will lead to increased growth in marsh grasses (and food supply) and an increase in the amount of habitat available, both of which will contribute directly to the increased abundance of fishes. Wetlands restoration and enhancement will minimize the effects of Salem-related losses by increasing productivity of these species and also benefiting other species dependent on the productivity derived from the wetlands.

Mitigation Features

PSE&G's wetlands restoration and enhancement program, carried forward in the 2001 permit (Special Condition 3), was developed to increase detrital production in the Delaware Estuary. The major components of the plan are as follows:

- Continue restoration of up to 10,000 acres of salt marsh wetlands.
- Restore an aggregate of no less than 8,000 acres of diked wetlands to normal daily tidal inundation so as to become functional salt marsh and/or wetlands dominated by common reed to primarily Spartina species with other naturally occurring marsh grasses. A minimum of 4,000 of the 8,000 acres restored must be diked wetlands.
- Restore an additional 2,000 acres of wetlands as set forth above and/or preserve in a state that precludes development through appropriate title ownership or Conservation Restriction no less than 6,000 acres of uplands adjacent to Delaware Estuary tidal wetlands ("Upland Buffer"). An Upland Buffer is an area of land adjacent to wetlands which minimizes adverse impacts on the wetlands and serves as an integral component of the wetland ecosystem.
- Implement Management Plans for the preservation and/or restoration of more than 18,500 acres of lands, wetlands and uplands including the 4,500 acre Bayside Tract.
- Continue operation and maintenance of eight fish ladders and construct two additional fish ladders.
- Continue the comprehensive Bay-wide monitoring program of the Delaware Estuary with specific improvements.
- Funding for the construction of artificial reefs.

The permit also requires the continuation of an advisory group (as established in the 1994 permit) to assist PSE&G in continued activities for the restoration of the salt marsh wetlands and the Bay-wide biological monitoring program. The advisory group, the Estuary Enhancement Program Advisory Committee (EEPAC) is comprised of independent scientists, representatives from regulatory agencies, and local representatives.

The restoration and enhancement program also includes a biological monitoring program for the Delaware Estuary. PSE&G has developed and implemented a biological monitoring program for the Estuary as required by the Permit. This program includes:

- Comprehensive thermal monitoring and performance of a biothermal assessment on the RIS.
- Bay-wide abundance monitoring.
- Impingement and entrainment monitoring.
- Abundance monitoring for ichthyoplankton and juvenile blueback herring and alewife in connection with fish ladder sites.
- Detrital production monitoring.
- Residual pesticide release monitoring (in salt hay impoundments).
- Other special monitoring studies including effects of sound deterrents as may be required by the Department and/or EEPAC.

Case 2: San Onofre Nuclear Generating Station

Background

The San Onofre nuclear generating station is a 3-unit site located near San Clemente, California, in San Diego County on a 84-acre site. The following summary of the San Onofre Nuclear Generating Station (SONGS) mitigation project derives from "Proceedings from the Second Annual Public Workshop for the SONGS Mitigation Project" (February 27, 2002), submitted to the California Coastal Commission (CCC) on April 3, 2002.

Overview of Required Mitigation

In connection with issuing a coastal development permit (CDP) to Southern California Edison (SCE) for the operation of SONGS Units 2 and 3, in 1974 the CCC required a study of the operation on the marine environment offshore from San Onofre, and mitigation of estimated adverse impacts. As a result of the studies, the CCC required SCE and its partners to:

- Create or substantially restore at least 150 acres of southern California wetlands.
- Install fish barrier devices at the power plant.
- Construct a 300-acre kelp reef.
- Provide the funds necessary for the CCC to retain scientific and support staff to oversee the site assessments, project design and implementation, and monitoring activities for the mitigation projects.
- Partially fund construction of an experimental white sea bass hatchery (added as a requirement in 1993).

In 1997, after reviewing new impact studies, the CCC approved amended conditions that:

- Reaffirmed the CCC's prior decision that San Dieguito is the site that best meets the CDP's standards and objectives for wetland restoration.
- Allowed up to 35 acres credit for enhancement of wetland habitat at San Dieguito Lagoon by keeping the river mouth permanently open.
- Revised the kelp mitigation requirements.

Mitigation Features

The mitigation program, initiated to mitigate estimated impacts to certain marine fish populations resulting from the operation of SONGS Units 2 and 3, contains the following components:

1. San Dieguito Lagoon Restoration Project

The SCE, in partnership with the San Dieguito River Park Joint Powers Authority (JPA) is working to carry out the final restoration plan, which was submitted to the CCC for approval in late 2001. A preliminary restoration plan was approved by the CCC in 1997 and was modified

after commencement of the NEPA and CEQA environmental review processes. Ultimately, one design – the "Mixed Habitat Plan" – was selected as the preferred alternative.

The Mixed Habitat Plan will employ a large subtidal basin and intertidal channels at the project site. Least tern nesting islands will be constructed at four locations and broad areas of salt marsh will border the river and the intertidal mudflats. The CDP calls for a one-time restorative dredging followed by maintenance dredging to maintain the inlet in an open condition following restoration. Beach-quality sand encountered during excavation will be used to top the nesting sites and supplement the beach, while other dredged soil will be used to construct the nesting site bases and the river berms. Excess dredge material will be disposed to several designated disposal sites, which will be vegetated following construction. The JPA will construct several interpretive trails around the restoration, as well as a visitor center.

2. Pre-Restoration Monitoring

Contract scientists retained by the CCC will conduct pre-restoration monitoring of the lagoon restoration project. The three objectives of the monitoring are to:

- Collect physical and biological data on pre-restoration conditions that will permit an assessment of construction-related impacts and changes in the existing wetland following construction.
- Evaluate sampling designs for the post-restoration monitoring of physical and biological attributes that will be used to evaluate performance of the wetland.
- Assess the suitability of other wetlands as reference sites.

3. Restoration Standards

Within 4 years of construction, total densities and number of species of fish macro-invertebrates must be similar to densities and number of species in similar habitats in reference wetlands. Of particular concern from a monitoring and sampling design point-of-view is spatial patchiness in the densities of wetland species.

4. Experimental Reef Design and Monitoring

The CCC has required construction of an artificial reef in two phases: an experimental phase, relatively short in duration (i.e., five years) and small in size (20-22 acres), and a subsequent larger mitigation reef (at least 150 acres) of duration equal to the operating life of SONGS Units 2 and 3 (i.e., 20-30 years). The purpose of the experimental reef is to determine which combinations of substrate type and substrate coverage will most likely achieve the performance standards specified in the CDP. The larger mitigation reef will be designed based on the results of the experimental reef. The CCC's contract scientists have produced a monitoring plan for the experimental kelp reef, which provides sampling methodology, analytical techniques and methods for measuring performance of the different experimental reef designs.

The CDP requires that the mitigation reef be constructed of rock, concrete or a combination of these materials, at a coverage that is suitable for sustaining giant kelp and

associated kelp forest biota similar in composition and diversity to nearby reference reefs. The mitigation also included various process studies designed to estimate parameters required to determine whether the mitigation reef will comply with the CDP conditions.

5. Continued Project Monitoring

Monitoring will be conducted to evaluate the effectiveness of the restoration project and artificial reef. Areas of focus will include the giant kelp, kelp forest benthic community, kelp-bed fishes and beach monitoring.

Case 3: Mirant Delta Contra Costa and Pittsburg Power Plants Background

Mirant Delta, LLC owns and operates two power plants in Contra Costa County, California known as the Contra Costa Power Plant and the Pittsburg Power Plant. Both plants withdraw once-through cooling water from the Sacramento-San Joaquin River Delta and discharge pursuant to NPDES permits issued by the Central Valley Regional Water Quality Control Board (in the case of the Contra Costa Power Plant) and the San Francisco Bay Regional Water Quality Control Board (in the case of the Pittsburg Power Plant). In prior permits, Mirant met BTA by implementing a Resource Management Program, improving intake structures and stocking hatchery striped bass in the Delta. Mirant is currently developing, in cooperation and consultation with USFWS, NMFS and CDFG, a comprehensive and integrated Conservation Program for the Pittsburg and Contra Costa Power Plants that includes habitat restoration and enhancement of the Montezuma Enhancement Site. The site is located on the north shore of the Sacramento River, roughly equidistant between the Contra Costa Power Plant and Pittsburg Power Plant.

Overview of Required Mitigation

Mirant will undertake habitat restoration, enhancement and aquatic and terrestrial conservation activities for selected Habitat Conservation Plan (HCP) species at the Montezuma Enhancement Site. The Montezuma Enhancement Site is a 139-acre site on which a conservation easement will be conveyed to protect species identified in the HCP. The site was formerly diked and farmed in the past and was used as a waterfowl hunting club. The conditions at the vast majority of the Montezuma Enhancement Site are marginal for all HCP-covered species.

Mirant will restore, enhance and conserve aquatic and terrestrial habitat to provide net benefits for selected listed species by restoring tidal flow and creating access through openings (about 100 feet in width) at the Sacramento River and Marshall Cut. Some areas of the Montezuma Enhancement Site will be left in their current condition to avoid disturbing habitat likely to be occupied by listed species. A conceptual plan has been developed with the goal of increasing the availability of near shore habitat used by sensitive aquatic species as well as identified terrestrial species. Detailed planning and implementation of the habitat restoration, enhancement and conservation plan will be implemented as soon as the ITPs are issued.

Mitigation Features

The primary goals of the restoration and enhancement measures are to increase the quality and quantity of habitat for the fish species targeted in the HCP and, at the same time, to enhance the sensitive terrestrial communities to the extent possible and consistent with the primary goal. The following habitat restoration and enhancement measures are planned for implementation at the Montezuma Enhancement Site:

- Convey a conservation easement pertaining to the real property of the Montezuma Enhancement Site, consisting of approximately 139 acres of undeveloped land, to CDFG for the conservation and protection of sensitive species identified in the plan. The conservation easement will be conveyed upon completion of the habitat enhancement activities on site. The easement will remain in effect in perpetuity.
- Restore tidal flow at the Montezuma Enhancement Site by creating openings (about 100 ft in width) at the Sacramento River and Marshall Cut.
- Recontour portions of the Montezuma Enhancement Site to create three dead-end sloughs of approximately 50 ft in width and 350 ft in length.
- Recontour the three constructed dead-end sloughs on the Montezuma Enhancement Site to increase the available tidal, intertidal and upper tidal zones.
- Increase the quantity and enhance the quality of northern coastal salt marsh and coastal brackish marsh on the Montezuma Enhancement Site.
- Contribute funding to complete the restoration and enhancement of the Montezuma Enhancement Site.
- Maintain existing fencing and control access to the site.

Survey and evaluation of the Montezuma Enhancement Site will be conducted 1, 2, 3, 5, 7 and 10 years after completion of restoration and enhancement activities to determine utilization of the site by HCP-covered species. Appropriate actions will be undertaken, in consultation with USFWS, NMFS and the CDFG, to correct habitat conditions as may be necessary.

An adaptive management program will be implemented to ensure that identified conservation measures are achieving their objectives. The adaptive management program will depend on the results of several monitoring and evaluation measures that will be undertaken to determine the effectiveness of the conservation activities. Mirant will provide periodic reports on the results of the monitoring and evaluation measures and the actions Mirant proposes to take, if necessary, to modify the overall conservation program in order to obtain the conservation goals or optimize their effectiveness.

Appendix B: Baseline Monitoring Proposal for Morro Bay

As an adjunct to the HEP, Duke is proposing to implement a baseline monitoring program in Morro Bay, as outlined in this appendix. The proposed monitoring program is consistent with EPA's proposed 316(b) regulations for existing facilities.

HEP monitoring includes hydrological, water quality, and biological monitoring components. The monitoring will enhance the existing NEP program and provide resource managers with the necessary information for monitoring the progress of the HEP projects. The hydrographic and sediment monitoring will provide direct information on the effectiveness of the sediment control projects. The benefits to the biological communities will also be monitored through aerial mapping of the various habitats in the bay. The spatial changes in bay habitat can be directly translated into productivity (g C•m -2). Finally, the proposed fish monitoring will provide information on one of the biological communities most affected by MBPP cooling water withdrawal.

The monitoring program will be designed to sample at temporal and spatial scales appropriate to the environmental and biological variability in the Bay (Callaway et al. 2001¹). The study design may sample more frequently at the start of the program, using the data to determine the optimal temporal and spatial scales for the ongoing sampling. Adaptive management of the monitoring will be used to re-evaluate the effectiveness of the program on regular intervals.

The baseline monitoring program will also extend the technical and financial capability of the existing NEP ecosystem-level monitoring program in coordination with its many staff and volunteer components. Although it is well known that monitoring the hydrology and topography of estuarine habitats is essential because these physical factors drive wetland ecology and development (Callaway et al. 2001), this usually requires expensive instrumentation and extensive surveys. Therefore, components of the HEP monitoring program include hydrographic surveys and instrumentation to monitor erosion and sedimentation and other physical water quality parameters. HEP record water quality instrumentation will be incorporated to provide real-time data that is presently recorded in the NEP monitoring program at monthly or quarterly intervals. However the core of the HEP monitoring are the ecological tracking components using aerial photography and spectral imaging to map changes in the abundance and distribution of the Morro Bay's habitat forming species (pickleweed, mudflat algae, and eelgrass) and synoptic field surveys of Morro Bay fish.

Monitoring Components

The HEP monitoring is based on the research of Callaway et al. (2001) who prioritized attributes to be monitored and presented an example monitoring program. The proposed program is presented in Table 1 and described in the subsequent sections. Duke anticipates that the cost of this monitoring program over the five-year life of the permit for the modernized plant will not exceed \$165,000.

1

Callaway, J.C., G. Sullivan, J.S. Desmond, G.D. Williams, and J.B. Zedler. *Assessing and Monitoring*. Pages 271-336 in J.B. Zedler, editor. *Handbook for Restoring Tidal Wetlands*. CRC Press, New York. 2001

Table 1: Proposed Baseline Monitoring Components

Attributes and measures	Methodology	Frequency
Hydrology and topography		
Elevation	Aerial photogrammetry, surveying	Initial, every 3-5 years
Inundation regime	Water quality instrumentation	Continuous (hourly)
Sediment accretion and erosion	Sediment cores	Annually
Creek morphology	Aerial surveys	Annually
Soils	·	
Texture	Sediment cores	2x year; spring and fall
Salinity	Sediment cores	2x year; spring and fall
рН	Sediment cores	2x year; spring and fall
Organic matter	Sediment cores	2x year; spring and fall
Total Kjeldahl nitrogen	Sediment cores	2x year; spring and fall
Water quality		
Temperature	Water quality instrumentation	Continuous (hourly)
Salinity	Water quality instrumentation	Continuous (hourly)
Dissolved oxygen	Water quality instrumentation	Continuous (hourly)
Turbidity	Water quality instrumentation	Continuous (hourly)
Nitrates	Water quality instrumentation	Continuous (hourly)
Vegetation		
Vegetation mapping	Aerial multi-spectral scanning	Annually
Eelgrass ground-truthing	Plant density, quality in plots	2x year; spring and fall
Eelgrass bed turbidity and PAR light	In situ turbidity and PAR meters	Continuous (hourly)
Eelgrass bed sedimentation	In situ sedimentation chambers	Continuous (hourly)
Invertebrates ²		- '
Eelgrass faunal association	Quadrat surveys and cores	2x year; spring and fall
Fishes ³	-	- -
Abundance and distribution by habitat	Multiple sampling gear	2x year; spring and fall

⁻

Of the \$165,000 budgeted for the baseline monitoring program, no more than \$8,000 per year will be allocated to the monitoring of invertebrates and fish. This amount is consistent with the NEP's proposed budget for this work. Given that there is no scientific method for indexing larval abundance and resulting adult fish populations, the results of this monitoring are not intended, and should not be used, as a metric for evaluating the success of individual restoration projects.

³ Ibid.

Hydrology and Topography

Bathymetry and elevation

A survey of the Bay's bathymetry and elevations in the intertidal mudflat and marsh areas will be conducted prior to the initiation of the HEP. A complete survey will be conducted every 3-5 years to provide information on the effectiveness of the HEP in maintaining and reducing sedimentation within the Bay. Bathymetry of the subtidal channels will be surveyed using a research-grade digital echosounder. Elevations of intertidal mudflat and other unvegetated areas will be surveyed using a erial photogrammetry, while the vegetated marsh areas will be surveyed using a kinematic GPS survey.

Inundation regime

Instrumentation for recording water quality parameters, including water depth, will be installed at several locations within the Bay. The tidal patterns differ throughout the Bay and periods of inundation are directly related to sedimentation rates. As a result, recordings will be taken at a minimum interval of once per hour. This data will be used to determine the potential for different sedimentation patterns in the Bay and how they are related to tidal inundation.

Sediment accretion and erosion

Several methodologies will be used to measure sediment accretion and erosion within the Bay. Large-scale surveys of the Bay's bathymetry and elevation will be conducted prior to the initiation of the HEP and at 3-5 year intervals thereafter. At several locations within the Bay, permanent stations will be established where more precise measurement will be taken on a more frequent basis. In vegetated areas that are primarily depositional, marker horizons will be used to monitor sediment accretion. Feldspar or glitter will be sprinkled in these areas and then sampled at later dates using a small transparent core or a cryogenic coring device (Callaway et al. 2001). In other areas, precision GPS (±5 mm) will be used to monitor elevations relative to a USGS datum. One potential outcome of the monitoring may be that areas of the back-bay near Baywood Park are shown to have lower rates of sedimentation than the mid-bay that is directly affected by outflows from Chorro and Los Osos creeks. If the rates in these areas are lower or at equilibrium it may be useful as a reference location that can be compared with other areas in Morro Bay.

Tidal channel morphology

Aerial digital imaging surveys will be used to monitor the morphology of the tidal channels that connect the vegetated marsh plains and mudflats with the adjacent open water areas. Changes in channel morphology can have marked effects on sedimentation rates, flushing times, and ultimately on productivity of the Bay's habitats. Maintaining a diverse network of tidal channels with a high density of small, first-order creeks provides the marsh areas with supplies of sediments and nutrients and flushes away salts and waste material.

Soils

Wetland soil characteristics are monitored to evaluate constraints on plant growth. Soil parameters will be measured at several permanent sites encompassing various habitats within the

Bay to characterize long-term changes in texture/grain size, salinity, pH, organic matter content, and total Kjeldahl nitrogen. These measurements will be correlated with patterns of sediment accretion and erosion in the watershed and Bay. This soil data can also provide information on Bay productivity and nutrient cycling. The sampling will be done during low tide twice annually to measure seasonal variation in nutrient concentrations. Cores will be collected with an apparatus designed to collect uncompacted soil cores. Replicate samples will be composited from the sample area to decrease sample variance and reduce analysis time and cost.

Water Quality

Multi-parameter digital recording instruments will be used to collect the following water quality parameters at several locations within the Morro Bay Estuary:

- Temperature
- Salinity
- Dissolved oxygen
- Turbidity
- Nitrates

These parameters can vary widely due to tidal conditions, time of day, and season. The recorders will provide a more continuous record of these water quality parameters than is currently available. In areas of the Bay where HEP projects have been implemented, water quality parameters will be important indicators of changes in circulation or tidal flushing.

Vegetation

Vegetation mapping

Aerial surveys using a multi-spectral digital video system will be used to map the various habitats in the Morro Bay estuary. The geo-referenced, raster images produced by the system will be analyzed using GIS to determine the aerial coverage of eelgrass, green algae, and marsh vegetation. This system has the ability to provide some penetration through the water column to detect submerged eelgrass and algae. The non-vegetated mudflat and subtidal areas will also be delineated. An aerial survey will be conducted each year during the late summer or fall when the eelgrass beds should be at the peak of their growing season. Changes in the spatial extent of the eelgrass beds will be used as a primary indicator of the success of the HEP sediment erosion projects.

Eelgrass bed ground-truthing

The density and condition of the eelgrass in the areas detected in the aerial survey will also be surveyed. The GIS will be used to generate a grid overlaying the eelgrass beds recorded from the aerial survey. The grid will be used to locate a random sample of up to 100 plots with a radius of 5 meters. The sampling will be stratified to ensure that all of the areas are adequately sampled. In each plot the actual density (number of turions) of eelgrass will be recorded, as well as the lengths of a sample of blades. These surveys will be done twice a year in spring and fall. The fall survey will be done following the aerial survey and will use those data to establish the

sampling points. The spring survey will be used to obtain data on seasonal changes in the spatial coverage, health, and density of the eelgrass. Sampling of associated fauna is described below.

Eelgrass bed turbidity, sedimentation, and photosynthetic active radiation

Physical water quality parameters will be monitored at paired monitoring stations (with eelgrass and without) with multiple probe water quality meters. Probes will include temperature, turbidity, salinity, and dissolved oxygen. The units will also be equipped with a depth gauge to track tidal conditions during the course of the monitoring and will have a custom modification to install a probe for measurement of photosynthetically active radiation (PAR) within the 400-700 nm range. The quantum sensor will be placed at an elevation in the eelgrass equal to the top of the eelgrass canopy and at a comparable elevation from the ground in unvegetated stations. To minimize eelgrass interference with probe sensors, eelgrass will be kept cleared from sensors by removing eelgrass shoots growing within a 0.75-meter radius around the station. Sensor data will be recorded in 20-minute intervals. In addition to the meter-collected water quality data, suspended sediment deposition will be monitored at each of the paired stations using a sediment collection cone. The sediment from the collection cone trap will be emptied and weighed (dry weight) monthly to determine the relative sediment load between stations and between station pairs.

Invertebrates⁴

Eelgrass beds provide habitat for a wide variety of invertebrate species that are important prey items for fishes. Monitoring changes in the abundance and diversity of invertebrates associated with differing densities of eelgrass will be one measure of habitat quality. Invertebrate groups include epibionts (fauna associated with blade surfaces), epibenthos (surface-dwelling fauna), and infauna (fauna living in the sediment). Sampling will be done twice annually in the spring and fall using a combination of quadrats, transects, and core samples, with concurrent samples of eelgrass biomass, density, and blade length. Macrofaunal counts will be done *in situ*, and fauna from core samples and small quadrat enclosures will be washed through a 0.5 mm screen and returned to the laboratory for identification and biomass determination.

Fishes⁵

A comprehensive fish inventory of Morro Bay will support long-term assessments of estuarine ecosystem health. Quantitative data, collected twice annually in spring and fall, will identify spatial distributions and seasonal abundance trends, and define critical fish habitats. The proposed study will use a variety of fish sampling devices in the different Morro Bay habitats to enumerate species and gain insight into their trophic ecology and population structure. Proposed sampling locations will be allocated between eelgrass, mudflat, channel, low marsh, and algal

Of the \$165,000 budgeted for the baseline monitoring program, no more than \$8,000 per year will be allocated to the monitoring of invertebrates and fish. This amount is consistent with the NEP's proposed budget for this work. Given that there is no scientific method for indexing larval abundance and resulting adult fish populations, the results of this monitoring are not intended, and should not be used, as a metric for evaluating the success of individual restoration projects.

⁵ Ibid.

mat habitats, each of which support different fish assemblages. A variety of sampling gear types is necessary to develop best estimates of abundance in these habitats (Allen 1999⁶). These include otter trawl, beam trawl, purse seine, large beach seine, small seine, and 1.0 m² enclosures.

Allen, L. G. *Fisheries Inventory and Utilization of San Diego Bay, San Diego, California.* Final Report: Sampling Periods July 1994 to April 1999. Prepared for the U.S. Navy, Naval Facilities Engineering Command; Southwest Division, and the San Diego Unified Port District. 1999.

Appendix C: HEP Compliance with EPA's Proposed Standard for Entrainment Reduction

The table Below depicts how these reductions in water usage would work towards achievement of the required level of entrainment reduction.

Table 1: EPA Proposed Standard for Entrainment

	Scenario		Residual Target
	Low	High	Reduction Range
Baseline Condition			10%
316 (b) Design basis ⁷	413	413	15%
EPA Performance Range	60%	90%	20%
Equivalent Water Use	165	41	25%
			30%
Reduction Basis 1			35%
Permit Flow Limitation ⁸	370	370	40%
Incremental Percent Reduction	-10%	-10%	45%
Residual Target Percent Reduction	50%	80%	50%
			55%
Reduction Basis 2			60%
True up for actual water use ⁹	328	328	65%
Incremental percent reduction	-10%	-10%	70%
Te Range of e reduction	-21%	-21%	75%
R possible residual t Percent Reduction	39%	69%	80%
targets or			85%
goals			90%
			95%

Looking at the scenario in Table 1, the baseline (413 MGD) reflects the plant at full load taking into account the inherent limitations posed by Duke's air quality permits. (Note that this is slightly lower than the flow rate used by Regional Board staff to calculate the proportional mortality figures for the modernized plant.) As such, 413 MGD represents an appropriate baseline for comparison purposes because it is tied to the Regional Board's assessment of entrainment effects. It is also the baseline Duke has used in the HEA analysis presented in Section 4.

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⁸ This flow level is the basis of Duke's voluntary measure.

This flow basis is hypothetical for illustration purposes and would relate to an approximate 80% capacity factor, a conservatively high assumption about the potential future operation of the plant.

Appendix D: HEA Model Output: Restoration Acres Required

The following illustrates the HEA model calculations for an eelgrass or coastal salt marsh restoration project. The steps of the HEA model are illustrated in Figure 1 below.

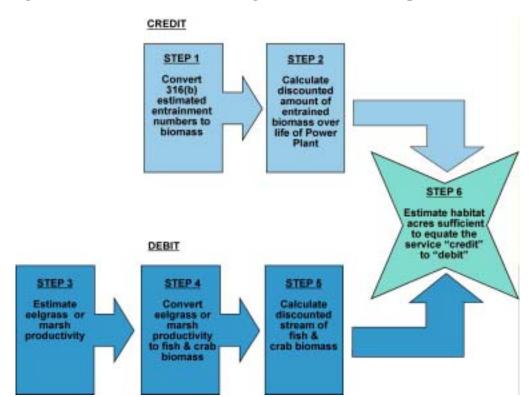


Figure 1: Procedure for Calculating Biomass Lost and Replaced

Step 1: Convert the 316(b) estimated annual entrainment from numbers to biomass

Tables 1 and 2 present the number and percent of entrained fish larvae and crab species. Columns 2 and 3 of Tables 1 and 2 contain the annual numbers entrained and the proportion of the annual entrainment for the species of fish larvae and crab megalope collected in the entrainment sampling of the 316(b) assessment (Tenera, 2001). 88% of the fish entrained at MBPP consisted of eight species, with the unidentified gobies making up 75% of the total fish larvae entrained (Table 1). The remaining 12% of entrained larvae consisted of numerous species that were combined in the "other" category. The brown rock crab (72%) and the hairy rock crab (15%) comprised 87% of the total entrained for shellfish (Table 2).

Table 1: Annual Fish Larvae Biomass Entrained

(1)	(2)	(3)	(4)	(5)		(6)	(7)
Species	Number	Proportion of Total	Max Length (mm)	Weight:Length Relationship		Max Weight (g)	Loss per Year (kg)
Unidentified goby	393,261,027	74.8%	8.2	W = 1.14x10-2 L(mm)2.918	(a)	5.3E-03	2,080
Pacific staghorn sculpin	17,321,398	3.3%	9.9	$\log W(g) = -5.243 + 3.134 \log L(mm)$	(b)	7.5E-03	131
Northern lampfish	14,548,803	2.8%	9.7	not available	(c)	7.4E-02	1,083
Shadow goby	13,503,587	2.6%	4.8	not available	(d)	5.3E-03	71
Combtooth blennies	10,042,151	1.9%	3.2	not available	(e)	5.3E-03	53
KGB rockfish	6,406,622	1.2%	5.4	W(g) = 1.299x10-5 L(mm)3.077	(f)	2.3E-03	15
Jacksmelt	3,777,821	0.7%	7.6	W(g) = 8.86x10-6 L(mm)3.03574	(h)	4.2E-03	16
Pacific herring	3,030,431	0.6%	7.5	W(g) = 4.3x10-3 L(cm)3.232	(i)	3.2E-03	10
White croaker	2,992,511	0.6%	15.7	W(g) = 3.3x10-5 L(mm)2.804	(g)	7.4E-02	223
other *	61,201,949	11.6%	N/A	N/A	(j)	1.6E-02	989
Totals	526,086,300	100.0%					4,670

^{*} includes all other species

⁽a) Brothers (1975)

⁽b) PSMFC (2000)

⁽c) assumed to equal the weight of white croaker

⁽d) assumed to equal the max weight of unidentified (arrow) goby

⁽e) assumed to equal the max weight of unidentified (arrow) goby

⁽f) PSMFC (2000); the largest value from equations for the three rockfish species was chosen (gopher rockfish)

⁽g) PSMFC (2000); FishBase reports the equation W(g) = 2.72x10-2 L(cm)2.943, which yields a weight of 0.006g

⁽h) PSMFC (2000) equation for topsmelt (none were available for jacksmelt)

⁽i) FishBase.org (2002)

⁽j) arithmetic average of the weights for unidentified (arrow) goby, Pacific staghorn sculpin, KGB rockfish, white croaker, jacksmelt (topsmelt), and Pacific herring

Table 2: Annual Crab Megalope Biomass Entrained

(1)	(2)	(3)	(4)	(5)	(6)
Species	Number	% of Total	Max Carapace Width (a) (mm)	Max Weight (b) (g)	Loss per Year (kg)
Brown rock crab	9,744,688	71.8%	10	0.22	2,141
Hairy rock crab	1,965,950	14.5%	10	0.22	432
Yellow crab	1,116,099	8.2%	10	0.22	245
Slender crab	470,025	3.5%	10	0.22	103
Cancrid crabs	140,217	1.0%	10	0.22	31
Red rock crab	85,705	0.6%	10	0.22	19
Dungeness crab	54,650	0.4%	10	0.22	12
Totals	13,577,334	100.0%			2,983

⁽a) based on carapace widths for post-larval Dungeness crabs (Collier, 1983)

⁽b) based on the weight: carapace width relationship for the blue crab $W(g) = 8.1636 \times 10^{-4} \text{ CW}(mm) \cdot 2.430 \text{ (Helser and Kahn, 2001)}$

Column 6 of Table 1 and Column 5 of Table 2 provide the estimated weights of fish larvae and crab megalope used for calculating the total biomass loss, respectively. The annual biomass loss was used to calculate the debit of the HEA model, as described in Step 2 below.

For fish larvae, the annual biomass lost was estimated by multiplying the annual number entrained (Table 1, Column 2) by the estimated maximum weight of a larvae (Table 1, Column 6).

As an example, based on the maximum length reported for arrow goby larvae of 8.2 mm (Tenera, 2001), the weight was estimated to be 5.3 mg. The use of 5.3 mg is considered conservative, since the length of an "average" sized goby (3.7 mm from Tenera, 2001) would yield a weight of 0.52 mg.

Weight:length relationships were not available for northern lampfish, shadow gobies, or combtooth blennies. The weight of northern lampfish was assumed to equal that of the white croaker, the largest larvae for which a weight was estimated. The weight of shadow gobies and combtooth blennies were assumed to equal that of unidentified (arrow) gobies, which were larger at the time of entrainment. These assumptions are considered to be conservative, as larger larvae were used to estimate the weights for smaller larvae.

The species included in the "other" category comprised a small proportion of the total larval entrainment. The weight of these fish was assumed to be the arithmetic average of the weights of the species for which a weight:length relationship was available, including unidentified (arrow) goby, Pacific staghorn sculpin, KGB rockfish, white croaker, jacksmelt (topsmelt), and Pacific herring. This assumption implies that the maximum length of entrained larvae and the weight:length relationship of fishes in the "other" category were similar to the species listed above.

Weight:length relationships were not available for any species of entrained crab megalope. All crab megalope were assumed to have a carapace width of 10 mm, which is a conservative size of Dungeness megalope based on the width of post-larval Dungeness crabs in the San Francisco Bay (Collier, 1983). It was assumed that since several other crabs in the Cancer genus attain similar adult sizes to the Dungeness crab (CADFG, 2002), the larvae are also similarly sized. A weight:carapace width relationship for blue crab (Helser and Kahn, 2001) was used to estimate the weight of the entrained crab megalope.

The estimated annual biomass lost is 4,670 kg for fish larvae (Table 3) and 2,983 kg (Table 4) for crab megalope.

Step 2: Calculate the discounted amount of entrained biomass over the life of the plant.

The debit of the HEA model is lost discounted fish and crab biomass, and was estimated as follows.

Based on the operational life of the proposed modernization, the annual biomass losses presented in Tables 1 and 2 were assumed to continue for 50 years. A 3% discount rate was

applied to the assumed biomass lost (and biomass produced by the restoration project). The 3% discount rate has been recommended for use in the HEA model (DOI, 1996; NOAA, 1996). Tables 3 and 4 contain the debit calculations for lost fish and crab biomass. The entrainment debit is 120,167 discounted kg (DKGs) for fish larvae and 76,759 discounted kg (DKGs) for crab megalope discounted over 50 years.

Table 3: The Debit for Entrained Fish Larvae

(1) Year	(2) Biomass Loss	(3) Discount	(4) Discounted
	(kg/yr)	Factor	Biomass Loss
		(r=3.0%)	(kg/yr)
1	4670	0.97	4534
2	4670	0.94	4402
3	4670	0.92	4274
4	4670	0.89	4150
5	4670	0.86	4029
6	4670	0.84	3911
7	4670	0.81	3797
8	4670	0.79	3687
9	4670	0.77	3579
10	4670	0.74	3475
11	4670	0.72	3374
12	4670	0.70	3276
13	4670	0.68	3180
14	4670	0.66	3088
15	4670	0.64	2998
16	4670	0.62	2910
17	4670	0.61	2826
18	4670	0.59	2743
19	4670	0.57	2663
20	4670	0.55	2586
21	4670	0.54	2511
22	4670	0.52	2437
23	4670	0.51	2366
24	4670	0.49	2298
25	4670	0.48	2231
	•••	•••	
49	4670	0.23	1097
50	4670	0.23	1065
Total			120,167

Table 4: The Debit for Entrained Crab Megalope

(1)	(2)	(3)	(4)
Year	Biomass	Discount Factor	Discounted
	Loss	(r=3.0%)	Biomass Loss
	(kg/yr)		(kg/yr)
1	2983	0.97	2896
2	2983	0.94	2812
3	2983	0.92	2730
4	2983	0.89	2651
5	2983	0.86	2573
6	2983	0.84	2498
7	2983	0.81	2426
8	2983	0.79	2355
9	2983	0.77	2286
10	2983	0.74	2220
11	2983	0.72	2155
12	2983	0.70	2092
13	2983	0.68	2031
14	2983	0.66	1972
15	2983	0.64	1915
16	2983	0.62	1859
17	2983	0.61	1805
18	2983	0.59	1752
19	2983	0.57	1701
20	2983	0.55	1652
21	2983	0.54	1604
22	2983	0.52	1557
23	2983	0.51	1512
24	2983	0.49	1468
25	2983	0.48	1425
• • •	• • •	•••	•••
49	2983	0.23	701
50	2983	0.23	681
Total			76,759

The following section presents an illustration of the HEA credit calculations. Actual restoration projects and their credit HEA calculations are presented in Chapter 5 and Appendix E, respectively. The following illustration assumes that eelgrass or coastal salt marsh will be restored within Morro Bay.

Step 3: Estimate eelgrass or marsh productivity as kilograms wet weight per acre per year (kg wet weight/acre/yr)

A conservative productivity value of 750 gm dry weight/m²/yr for both coastal marsh and eelgrass was applied in the HEA analysis (Tables 5 and 6). A conservative dry to wet weight ratio of 15% was used to convert dry weight productivity to wet weight productivity of the eelgrass or coastal marsh:

 $(750) / (15\%) = 5,000 \text{ gm wet weight/m}^2/\text{yr.}, \text{ or } 5.0 \text{ kg wet weight/m}^2/\text{yr.}$

Dry to wet weight factors from productivity studies of eelgrass in Humboldt Bay ranged from 7.0% to 16.4% with an average of 12.2% (Butler, 1979). The 15% value applied for both eelgrass and coastal marsh is a conservative value (i.e., the higher the dry to wet weight factor, the lower the productivity value).

Wet weight productivity was then converted to productivity per acre, using the equality that $4.047 \text{ m}^2 = 1$ acre:

(5.0) X (4,047) = 20,235 kg wet weight/acre/yr.

Step 4: Convert eelgrass or marsh productivity to fish and crab biomass produced per acre per year (kg/acre/yr)

Habitat restoration projects directly produce plant biomass. In this analysis, the selected metric was fish and crab biomass. Thus, the credit was converted into fish and crab biomass per acre produced by the restoration projects. Energy transfer (trophic level) models estimate the proportion of biomass that passes from one trophic level to another in the food web and were used to convert larval biomass lost to equivalent plant biomass production.

To obtain the overall efficiency from plant biomass (or detritus) to fish biomass, multiplying the trophic transfer efficiencies (4% for primary consumers and 10% for secondary consumers) yields a value of 0.4%. Because crabs are primarily dertritivores, the trophic level transfer efficiency from plant biomass to crab biomass is the efficiency for primary consumers, which is 4%. Thus, one acre of eelgrass or marsh habitat would provide (20,235*0.4%) = 80.94 kg of fish habitat or 809.4 kg of crab biomass.

Step 5: Calculate the discounted stream of fish and crab biomass produced per acre of habitat enhancement

For this illustration, it was assumed that the project would be implemented two years after the NPDES permit approval. Because the fish biomass resulting from the restoration projects does not occur instantaneously once the project is completed, the fish biomass produced must be projected over time.

For this illustration, it was assumed that plant biomass produced would increase linearly from 0 kg immediately following restoration project completion to 20,235 kg/yr after five years. It is assumed that fish and crab biomass would increase at the corresponding rates based on the appropriate trophic level efficiencies. The total lifespan of the project is assumed to be 100 years.

Tables 5 and 6 contain the credit calculations for this illustrative eelgrass or salt marsh creation project. Based on the assumptions above, the credit is approximately 2,232 discounted kg for fish and 22,320 for crabs.

Table 5: Credit Generated per Acre of Eelgrass or Coastal Salt Marsh Restoration (Fish)

Year After	Habitat	End of Year Fish	Annual	Discounted
Base Year	Services	Biomass Produced per	Credit	Credit
		Acre (kg/yr)	(kg/year)	(kg/yr)
1	0%	0.00	0.00	0.00
2	0%	0.00	0.00	0.00
3	20%	16.19	8.09	7.41
4	40%	32.38	24.28	21.57
5	60%	48.56	40.47	34.91
6	80%	64.75	56.66	47.45
7	100%	80.94	72.85	59.23
8	100%	80.94	80.94	63.89
9	100%	80.94	80.94	62.03
10	100%	80.94	80.94	60.23
11	100%	80.94	80.94	58.47
12	100%	80.94	80.94	56.77
13	100%	80.94	80.94	55.12
14	100%	80.94	80.94	53.51
15	100%	80.94	80.94	51.95
16	100%	80.94	80.94	50.44
17	100%	80.94	80.94	48.97
18	100%	80.94	80.94	47.54
19	100%	80.94	80.94	46.16
20	100%	80.94	80.94	44.81
21	100%	80.94	80.94	43.51
22	100%	80.94	80.94	42.24
23	100%	80.94	80.94	41.01
24	100%	80.94	80.94	39.82
25	100%	80.94	80.94	38.66
	•••			
101	100%	80.94	80.94	4.09
102	100%	80.94	80.94	3.97
Total				2,231.97

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Table 6: Credit Generated per Acre of Eelgrass or Coastal Salt Marsh Restoration (Crabs)

Year After Base	Habitat	End of Year Crab	Annual	Discounted
Year	Services	Biomass Produced	Credit	Credit
		per Acre (kg/yr)	(kg/year)	(kg/yr)
1	0%	0.00	0.00	0.00
2	0%	0.00	0.00	0.00
3	20%	161.88	80.94	74.07
4	40%	323.76	242.82	215.74
5	60%	485.64	404.70	349.10
6	80%	647.52	566.58	474.50
7	100%	809.40	728.46	592.30
8	100%	809.40	809.40	638.95
9	100%	809.40	809.40	620.34
10	100%	809.40	809.40	602.27
11	100%	809.40	809.40	584.73
12	100%	809.40	809.40	567.70
13	100%	809.40	809.40	551.16
14	100%	809.40	809.40	535.11
15	100%	809.40	809.40	519.52
16	100%	809.40	809.40	504.39
17	100%	809.40	809.40	489.70
18	100%	809.40	809.40	475.44
19	100%	809.40	809.40	461.59
20	100%	809.40	809.40	448.15
21	100%	809.40	809.40	435.09
22	100%	809.40	809.40	422.42
23	100%	809.40	809.40	410.12
24	100%	809.40	809.40	398.17
25	100%	809.40	809.40	386.57
	•••	•••	•••	•••
101	100%	809.40	809.40	40.89
102	100%	809.40	809.40	39.70
Total				22,319.67

Step 6: Estimate habitat acres sufficient to equate the service "debit" to "credit"

The general equation for the HEA analysis in this model is:

$$Restoration\ Project\ Size\ (acres) = \frac{Debit\ (DSAYs)}{Credit\ (DSAYs/acre)}\ .$$

Table 7 presents the restoration project size to compensate for entrainment and impingement of fish and invertebrates.

Table 7: Illustration of HEA Credit and Required Acreage from Eelgrass or Coastal Salt Marsh Creation Projects

	Biomass Entrained (Debit (kg))	Production (Credit (kg/acre))	Acres Required to Produce Entrained Biomass
Fish larvae	120,167	2,232	53.8
Crab larvae	76,759	22,320	3.4
Total Acres			57.2

Appendix E: HEA Results for Representative Projects

This section presents the results of the HEA model for the projects proposed in Section 5. In order to calculate the relative contribution of different projects to the fish and crab debits, it is convenient to present a combined debit, fish biomass in this case. All debits are listed in discounted kilograms, abbreviated here as "DKGs". The crab debit (76,759 DKGs) was multiplied by the 10% transfer efficiency of crab to fish biomass (from the energy transfer model) to yield an equivalent fish debit of 7,676 DKGs. This was combined with the fish debit (120,167 DKGs) to yield a total debit of 127,843 DKGs.

The credit for each of the proposed restoration projects was then measured in terms of fish biomass. Table 1 presents the credit generated by each of the proposed projects, followed by the assumptions for each proposed project.

Table 1: Credit Generated by the HEP Proposed Projects

Project	Credit (DKGs)	% Offset of Debit
1. Hoary Cress	40,175	31.4%
2. Mudflat/Eelgrass	36,824	28.8%
3. Sand Spit	4,374	3.4%
4. Chorro Flats II	34,554	27.0%
5. Hollister Ranch	20,525	16.1%
6. CalPoly/Walter's Ranch	344	0.3%
Total Offset		107.0%

The results provided in Table 8 were generated with HEA based on the project assumptions summarized below.

Removal of Hoary Cress Project

The DKGs provided by the 18-acre Hoary Cress project were estimated using the HEA model. Based on the assumptions below, the project will provide 40,175 DKGs over 100 years, which will compensate for 31.4% of the debit.

Category	Project assumptions
Base year	The year of permit approval
Time to implementation	2 years
Services provided	Primary production only
Sediment deposition	N/A
Loss prevention	N/A
Growth of services	From 0% to 100% over 5 years

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Category	Project assumptions
Project lifespan	100 years
Degradation of habitat	None within 100 years
productivity	
Current habitat	Provides no primary production exported to aquatic
	species
Annual production	750g dry weight/m ² (at full production with 100%
	services)
Discount rate of future services	3%

Restoration of Mudflat and Eelgrass

The DKGs provided by the 16-acre mudflat/eelgrass restoration project were estimated using the HEA model. Based on the assumptions below, the project will provide 36,824 DKGs over 100 years, which is 28.8% of the debit.

Category	Project assumptions
Base year	The year of permit approval
Time to implementation	2 years
Services provided	Primary production only
Sediment deposition	N/A
Loss prevention	Primary production of epiphytic algae in the
	eelgrass will offset the loss of microphytobenthic
	primary production on the mudflats
Growth of services	Linear growth from 0% to 100% over 3 years
Project lifespan	100 years
Degradation of habitat	None within 100 years
productivity	
Current habitat	N/A
Annual production	750g dry weight/m ² (at full production with 100%
	services)
Discount rate of future services	3%

Sand Spit Stabilization

The DKGs provided by the Sand Spit Stabilization Project were estimated using the HEA model. Based on the assumptions below, the project will provide 4,734 DKGs over 100 years, which is 3.4% of the debit.

Category	Project assumptions
Base year	The year of permit approval
Time to implementation	2 years
Services provided	For 50 years it will prevent 3 acres of eelgrass
	habitat from being lost due to sand spit migration
Sediment deposition	N/A
Loss prevention	Prevents 3 acres of eelgrass from declining linearly

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Category	Project assumptions
	to 0 acres over 10 years
Growth of services	N/A
Project lifespan	Benefits stop accruing after 50 years
Degradation of habitat	N/A
productivity	
Current habitat	N/A
Annual production	750g dry weight/m ² for eelgrass
Discount rate of future services	3%

Chorro Flats—Phase II

The DKGs provided by the Chorro Flats 2 Sediment Control Project were estimated using the HEA model. Based on the assumptions below, the project will provide 34,554 DKGs over 50 years, which is 29.0% of the debit.

Category	Project assumptions
Base year	The year of permit approval
Time to implementation	2 years
Services provided	168,000 cyds of sediment captured over 30 years
Sediment deposition	2 feet sediment deposition on low salt marsh in
	Zone 4 would cause it to become high salt marsh;
	sediment captured would have been deposited on
	low salt marshes in Zone 4
Loss prevention	Prevents loss of 52.1 acres of low salt marsh habitat
	in Zone 4
Growth of services	An equal amount of sediment is captured each year
Project lifespan	Benefits stop accruing after 50 years
Degradation of habitat	N/A
productivity	
Current habitat	N/A
Annual production	750g dry weight/m ² for low salt marsh
Discount rate of future services	3%

Hollister Ranch Sediment Control

The DKGs provided by the Hollister Ranch sediment control project were estimated using the HEA model. Based on the assumptions below, the project will provide 20,543 DKGs over 100 years, which is 16.1% of the debit.

Category	Project assumptions
Base year	The year of permit approval
Time to implementation	2 years
Services provided	86,250 cyds of sediment captured over 50 years
Sediment deposition	2 feet sediment deposition on low salt marsh in

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Category	Project assumptions
	Zone 4 would cause it to become high salt marsh;
	sediment captured would have been deposited on
	low salt marshes in Zone 4
Loss prevention	Prevents loss of 26.7 acres of low salt marsh habitat
	in Zone 4
Growth of services	An equal amount of sediment is captured each year
Project lifespan	Benefits stop accruing after 50 years
Degradation of habitat	N/A
productivity	
Current habitat	N/A
Annual production	750g dry weight/m ² for low salt marsh
Discount rate of future services	3%

CalPoly—Walter's Ranch Sediment Control

The DKGs provided by the CalPoly—Walter's Ranch Sediment Control Project were estimated using the HEA model. Based on the assumptions below, the project will provide 344 DKGs over 50 years, which is 0.3% of the debit.

Category	Project assumptions
Base year	The year of permit approval
Time to implementation	2 years
Services provided	1,445 cyds of sediment captured over 50 years
Sediment deposition	2 feet sediment deposition on low salt marsh in Zone 4 would cause it to become high salt marsh; sediment captured would have been deposited on
	low salt marshes in Zone 4
Loss prevention	Prevents loss of 0.5 acres of low salt marsh habitat in Zone 4
Growth of services	An equal amount of sediment is captured each year
Project lifespan	Benefits stop accruing after 50 years
Degradation of habitat productivity	N/A
Current habitat	N/A
Annual production	750g dry weight/m ² for low salt marsh
Discount rate of future services	3%

Appendix F: HEA Precedents and Case Histories

The following includes summaries of various matters that resulted in injuries to natural resources. Each settlement used HEA as the methodology to determine the sufficiency of the settlement.

The Application of HEA in its Early Years to Oil and Chemical Spills <u>USA; State of New Jersey and State of New York v Exxon Corp;</u> (1991) Arthur Kill, New Jersey

In January of 1990, a pipeline owned by Exxon Corp. ruptured beneath the Arthur Kill (saltwater channel between New Jersey and Staten Island, New York), spilling approximately 567,000 gallons of fuel oil. Over 100 acres of salt marsh were oiled, killing vegetation, fish crabs, clams and other invertebrates.

Exxon paid \$10 million in civil settlement to the federal and state natural resource trustees (NOAA, DOI, State of New Jersey, and State of New York), a portion of which was paid directly to the City of Elizabeth and City of New York for response costs. The consent decree dictated that the remainder of the \$10 million be used for: the acquisition of lands within the NJ/NY harbor in restoration or replacement of natural resources that have been damaged, the restoration and protection of lands acquired with such payments and the performance of studies in the NJ/NY harbor and related ecosystems including Arthur Kill. Also, \$1.5 million paid by Exxon for criminal restitution was allocated for the restoration of natural resources.

To date, the trustees have accomplished the following with the restoration funds: six acres of intertidal salt marsh along Arthur Kill shoreline has been restored, over 30 acres of land on Staten Island has been purchased, 25 acres of freshwater wetlands and forested uplands at the headwaters of a significant tributary to the Arthur Kill has been purchased and a 25-acre restoration project in another significant tributary to Arthur Kill will be conducted. HEA was used to arrive at the settlement and to scale restoration offsets.

<u>USA and State of Louisiana v Greenhill Petroleum;</u> (December 1993) Timbalier Bay, Louisiana

On September 29, 1992, a natural gas and petroleum well in Timbalier Bay, Louisiana experienced a "blow-out" and began discharging crude oil and natural gas in the bay. The well was owned and operated by Greenhill Petroleum Corporation. The blow-out resulted in the discharge of approximately 96,000 gallons of oil off the coast of Louisiana. The injury to natural resources included impacts to sediments, coastal marsh vegetation, migratory birds and aquatic natural resources.

The Department of the Interior (DOI) acted as the federal natural resource trustee, while the State of Louisiana was represented by the Oil Spill Coordinator's Office, the Office of the Governor, the Department of Environmental Quality, the Department of Natural Resources, the Office of Coastal Restoration and Management and the Department of Wildlife and Fisheries.

This settlement was arrived at through the use of HEA. The Greenhill settlement reports the injury in terms of service-acre-years ("SAYs"), which is the unit of measurement found in

HEA. The Trustees assessed the oil discharge to have resulted in 43.4 lost acre years of marsh services. To replace the lost marsh services, the restoration plan consisted of the creation and planting of 19.7 acres of new intertidal marsh habitat and vegetative planting of two acres of unvegetated sand castover area.

USA v Tsacaba Shipping Co., Inc.; (1999) Florida Keys, Florida

On August 10, 1993, an oil spill occurred as a result of several shipping collisions in Tampa Bay. The Trustees, (DOI, NOAA, and the Florida Department of Environmental Protection) filed a complaint pursuant to the Oil Pollution Act seeking damages for injury to natural resources, assessment costs and response costs arising from the oil spill. Mangroves, seagrass, saltmarsh and shellfish were exposed to oil and allegedly suffered injuries and interim ecological service losses. Oil also came into contact with sea turtles and their nests, birds, beach sands, subtidal sediments and the water column. The complaint also alleged that public beaches and waterways suffered a loss of recreational services; however, these losses were not addressed by the settlement.

HEA was used to evaluate proposed restoration activities. To provide full and final compensation for injuries, including lost services, the defendants agreed to design and implement a mangrove restoration plan and implement a salt marsh restoration.

<u>State of Texas v. Koch Industries</u>; (1994/2002) (Consent Decree pending) Corpus Christi, Texas

In October of 1994, Koch Pipeline Company experienced a release of 2151 barrels of crude oil from an oil transmission pipeline in Corpus Christi, Texas. The release resulted in the oiling of Gum Hollow Creek, Nueces Bay and portions of Corpus Christi Bay. Subsequently, the trustees pursued a natural resource damage claim under the CWA and state laws. Koch and the trustees conducted an expedited cooperative damage assessment, which focused on restoration rather than expensive, time-consuming studies. CG&S facilitated the settlement of the NRD claim.

All parties, while not yet finalized, have accepted the settlement. The settlement project involves the construction of approximately 2.3 acres of emergent wetlands in Nueces Bay and the acquisition of approximately 25 acres of upper marsh in the Nueces Bay watershed. Koch has successfully completed the construction of the emergent wetlands and is currently conducting the monitoring phase of the restoration. HEA was used to arrive at the settlement and to scale restoration offsets.

<u>USA v Chevron USA Production Co.</u>; (December 1995) Dixon Bay, Louisiana

On January 12, 1995, a wellhead on an inactive well located in Dixon Bay, 10 miles south of Venice, LA, suffered a failure resulting in oil slicks covering at least 25 square miles of Dixon Bay. Chevron owned the well.

The Trustees (NOAA, Louisiana Department of Wildlife and Fisheries, Louisiana Department of Environmental Quality, and Louisiana Department of Natural Resources) participated with Chevron in a cooperative process to assess the impacts to natural resources due

to the well blowout. The resource categories injured as a result of the release were marsh, bird/wildlife and the water column.

Using the HEA approach, the Trustees determined that the creation of approximately five acres of marsh by a freshwater diversion project would provide adequate compensatory restoration for the injuries to the marsh. The Trustees also determined that the freshwater diversion project would additionally satisfy compensatory requirements for water column and bird/wildlife lost services by creating intertidal and subtidal mudflats that will support a variety of plant and animal species, thereby providing food resources for birds and wildlife.

Ohio/Indiana v Arco Pipeline; (1994/95) Butler, Indiana

In 1995, Arco Pipeline experienced a leak near Butler, Indiana. Because the line was located in a very remote part of the state of Indiana, the leak went undetected for several days. During that time, approximately 850 bbls. of diesel entered into Fish Creek. Fish Creek was designated as critical habitat for the endangered Pearly White Cat's Paw mussel. The creek was also the home site of two other endangered freshwater mussels and three threatened species of freshwater mussels.

HEA was used to determine the sufficiency of the compensation and the matter was settled. For restoration, Arco Pipeline funded riparian corridor acquisition and reforestation in partnership with the Indiana state chapter of The Nature Conservancy ("TNC").

USA and State of Louisiana v Conoco, Inc.; (March 1997) Lake Charles, Louisiana

The federal and state trustees jointly sued Conoco for injuries to natural resources related to a release of 1,2-dichloroethane from the Marine Terminal at the Conoco Refinery in Lake Charles, Louisiana. The injury determination focused primarily on benthic community, sediment, surface water and fish. The Trustees used HEA to determine the appropriateness of the compensatory restoration.

The compensatory restoration involved the acquisition of property, conservation through placement of 50-year conservation easement over the property and reforestation of 41 acres of bottomland hardwood wetlands that had been denuded for agricultural use. Conoco also implemented a vegetation management program from the 41 acres in conjunction with the reforestation activities. This highly successful wetlands restoration is now more than five years old.

USA v Yellowstone Pipe Line (YPL); (1997) Missoula, Montana

As a result of a pipeline release on the Salish Kootenai Reservation, which initially impacted uplands but eventually entered into Camas Creek, the federal trustees sued Conoco Inc. for damage to natural resources.

HEA was used to establish the sufficiency of the NRD settlement. As part of the settlement, Conoco agreed to construct a fish ladder around a diversion dam constructed on the Jocko River. The ladder would reconnect two fragmented populations of endangered Bull trout and assist in ensuring the survival of this species.

USA v Equilon Pipeline Co.; (2001) Houston, Texas (aka Colonial Pipeline spill)

As a result of an oil discharge into the navigable waters and adjoining shoreline in the vicinity of the San Jacinto River in October 1994, the Trustees (DOI, NOAA, USFWS, TNRCC, Texas Parks and Wildlife Department, and the Texas General Land Office) filed a complaint pursuant to the OPA seeking natural resource damages.

The area impacted by the spill was divided into two areas: (1) north of the I-10 river bridge, and (2) south of the I-10 river bridge. The north of I-10 study area focused primarily on potential injury related to the oiling and burning of forested and herbaceous habitats. The south of I-10 study area focused on coastal wetlands as the primary habitat of concern. These habitats were injured as a direct result of contact with the discharge oil and as a result of exposure to floating burning oil. Also, biological resources may have been injured through ingestion of or exposure to the discharged hydrocarbon material.

Results from the HEA process indicate that the construction of 8.2 acres of emergent estuarine wetlands, 0.9 acres of freshwater wetlands and either the construction of 32.8 acres or the preservation of 100 acres of mixed forest habitat are required to compensate the public for injuries resulting from the incident.

<u>USA and the State of Louisiana v M/V Westchester</u>; (November 2000) Lower Mississippi River, Louisiana

In November 2000, the M/V Westchester oil spill incident injured natural resources on the Mississippi River. The injured resources included finfish and shellfish, birds, freshwater river vegetative habitat, delta marsh habitat, rip-rap habitat and sandflat habitat. Also, recreational fishing was a human use activity that was affected during the oil spill incident.

The Trustees (Louisiana Oil Spill Coordinator's Office, Louisiana Department of Natural Resources, Louisiana Department of Environmental Quality, NOAA, and USFWS) used HEA to scale the restoration activities based on compensation for lost services.

The Trustees selected marsh creation as the compensatory restoration project for the ecological resource injuries and increasing access to the natural resources in the Mississippi River delta as the general restoration alternative to compensate for lost human use due to the oil spill incident.

USA v Texaco; (1997) Lake Barre, Louisiana

In May 1997, a ruptured Texaco pipeline spilled 275,000 gallons of crude oil into Lake Barre, Louisiana, part of the Barataria/ Terrebonne National Estuary System. The spill impacted approximately 4,327 acres of marsh and caused injury to marsh, intertidal, subtidal and water column habitats and to the fish, wildlife and vegetation that occur in those habitats. Texaco entered into a cooperative Natural Resource Damage Assessment (NRDA) with state and federal trustees including NOAA, SFWS, Louisiana Oil Spill Coordinators Office (LOSCO), Louisiana Department of Wildlife and Fisheries (LDWF), Louisiana Department of Natural Resources (LDNR), and Louisiana Department of Environmental Quality (LDEQ). The Cooperative

NRDA group worked together to assess the injuries and quantify the value of the proposed restoration project.

The trustees used a standard model to estimate that 7,465 Kg of aquatic fauna including fish, crabs and shrimp were lost as a result of the spill. The model estimated the direct mortality of individuals due to exposure to the oil plus the loss of growth of the individuals had they lived. Using a different model, Texaco estimated less than 500 Kg of aquatic fauna were lost. The trustees estimated that 333 birds were killed as a result of the spill, but Texaco estimated that less than 100 birds were killed. Although their injury estimates differed significantly, Texaco agreed to a restoration plan that was more than adequate to compensate for the trustee's estimate of the injury.

The trustees and Texaco worked cooperatively to estimate injury to the marsh. Using HEA, they estimated that 75.6 Discounted Service Acre Years (DSAYs) of marsh services were lost as a result of the spill. The HEA analysis was performed separately for several different injury classes to reflect different amounts of oil and different plant responses to the oil. For each injury class, the reduction of services relative to a baseline level of services produced by uninjured marsh was estimated for each time interval until the full recovery of marsh was expected. This reduction in services was then entered into the HEA model and the total DSAYs of lost services was calculated.

The trustees selected marsh creation as the preferred restoration project to compensate for injuries to marsh, aquatic fauna and birds. The number of birds and biomass of aquatic fauna was translated into marsh production using a trophic model that estimated the DSAYs of marsh required to replace the lost birds and aquatic organisms. The trophic model used literature values for the efficiency of energy transfer between trophic levels to calculate the grams of plants required to produce the organisms killed. Each organism that the trustees estimated to have been killed was assigned a position in the food chain. For example, if the transfer efficiency from plants to the herbivores that consume them is 10%, then 10 grams of primary productivity is needed for every gram of herbivore produced. If the efficiency from herbivore to primary carnivore is 20%, then to produce a gram of primary carnivore, 5 grams of herbivore are required. Therefore, for every gram of primary carnivore, 50 grams of plants are required. The total biomass of plants required to produce all the biomass killed was considered the new debit.

The amount of primary productivity per acre that was expected from a created marsh was determined by examining the available literature on primary productivity. This value was used as the service flow from a marsh creation project in a HEA analysis to determine the size of marsh to satisfy the debit. From this analysis, the trustees determined that 3.18 to 3.35 acres of marsh creation was needed to compensate for the faunal injuries.

The implementation of marsh grass planting to stabilize a barrier island was selected to compensate for the injuries. This project will be considered a success if the planted marsh achieves 80% cover in three years. If the habitat meets this criterion, it is assumed that the appropriate biomass will be produced by the project.

<u>USA v Pepco</u>; (April 2000) Chesapeake Bay, Maryland

On April 7, 2000, a ruptured pipeline near the Chalk Point Generating Station released approximately 126,000 gallons of oil into Swanson Creek, a tributary to the Patuxent River and the Chesapeake Bay. A natural resource damage assessment (NRDA) was undertaken to identify and quantify injuries to natural resources and to identify restoration projects that would compensate for the loss of ecological and human use services that would have been provided by the natural resources had the spill not occurred.

The trustees for the Chalk Point Oil Spill included NOAA, USFWS, the Maryland Department of the Environment (MDE), and the Maryland Department of Natural Resources (MDNR). The representative parties (RP) were Potomac Electric Power Company (PEPCO) and ST Services, Inc. ENTRIX, Inc. was involved in the NRDA process, working with trustee agencies on the injury assessments, identification and selection of potential restoration projects and the scaling of restoration projects to the injuries using the HEA model.

Injury assessments were performed for the following natural resources and/or services: marsh, shoreline, and water column habitats; biota including birds, fish, muskrats, terrapins; benthic invertebrates; and lost recreational use. Projects identified to compensate for injuries to these resources include marsh restoration to compensate for marsh and muskrats; beach stabilization to compensate for shoreline and terrapin injuries; oyster bed and/or marsh restoration to compensate for bird, fish, muskrat, and benthic invertebrate injuries; and funding of proposed projects to increase or enhance recreational opportunities in the area to compensate for lost human use services.

A number of methods were used to determine the size of oyster bed and/or marsh restoration projects that would be required to offset injuries to birds, fish, and benthic invertebrates. These two potential restoration projects were scaled to the injury by utilizing a trophic-level model that estimated the amount of biomass of birds, fish, and benthic invertebrates produced by the oyster bed and marsh restoration projects. This biomass was then scaled to the injury (measured in biomass) using a Habitat Equivalency Analysis (HEA) model.

As described in the scaling document, "both [restoration] options will directly enhance production of [injured] biota relative to the habitat replaced by the restoration. The biota directly enhanced by the restoration project in turn will enhance populations of other biota that reside at higher trophic levels within the local food web. This scaling approach seeks to replace the lost biomass (measured in kilograms or similar units) caused by the spill with an equivalent biomass, taking into account trophic level differences between biota injured by the spill, biota directly restored by the restoration project and predators that consume them" (McCay, et.al., 2002).

McCay, Peterson, and Donlan. Restoration Scaling of Benthic, Aquattic, and Bird Injuries to Oyster Reef and Marsh Restoration Projects. April 6, 2002.

Superfund Sites

<u>USA and State of California v PRPs for the Heckathorn Superfund Site;</u> (February 2000) Tubbs Island. California

Releases of DDT and dieldrin into the Lauritzen Channel from the Heckathron Superfund Site resulted in natural resource injuries to fish, benthic invertebrates and fish-eating birds.

The Trustees (USFWS, NOAA, and the State of California) used HEA to estimate the cost of restoration of habitat that would provide comparable services to the injured natural resources. This value (\$365,000) formed the basis of the settlements with the responsible parties for natural resource damages. A Consent Decree signed by the responsible parties and the government provided these funds to carry out the restoration efforts.

USA v Hercules Incorporated; (January 1999) Jacksonville, Arkansas

This natural resource damage settlement is related to the Vertac Superfund Site, in Jacksonville, Arkansas. The Trustees were injured as a result of the release of hazardous substances (including pesticides, herbicides and other waste materials) from the site into the soil, surface and ground water, and sewage system and had also migrated into off-site areas. The federal Trustees sought damages to natural resources in a separate action from the State of Arkansas trustees, who settled out the State's claim approximately one year prior to the federal settlement. HEA methodology was used to determine the appropriate amount of compensatory restoration.

The Trustees agreed to the restoration of bottomland hardwood habitat at the Bald Knob National Wildlife Refuge. Hercules funded the construction of a water control structure anticipated to result in the inundation of 4,000 to 5,000 acres of forested wetlands and the reforestation of approximately 1750 acres of degraded agricultural lands to reestablish bottomland hardwood wetlands.

USA and State of Texas v Alpha Metals and Amoco; (May 2000) Texas City, Texas

This settlement is related to the Tex Tin Superfund Site in Texas City, Texas. The federal and state Trustees jointly sought damages for injury to natural resources, primarily sediments and benthic organisms, due to the release of hazardous substances into aquatic habitats. Groundwater was impacted and was the subject of remedial efforts. HEA methodology was used to scale the compensatory restoration.

The Trustees determined that the creation of 94.7 acres of salt marsh habitat would be required to adequately compensate for the natural resource injuries associated with the site.

<u>USA and State of Texas v BFI</u>; Chevron Chemical Co.; Chevron EMC, et al.; (June 2000) Port Arthur, Texas

The Bailey Waste Disposal Site is located within an estuarine marsh, bounded by undeveloped lands and agricultural tracts. Due to the placement of hazardous wastes in certain areas of the site, estuarine resources were injured due to the migration of hazardous substances into the adjacent salt marsh, were likely harmed by exposure to surface waters contaminated by releases of the hazardous substances and were also injured or destroyed by the excavation and

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capping undertaken to implement remedial actions at the site. The Trustees (DOI, USFWS, NOAA, TNRCC, Texas Parks and Wildlife Department and the Texas General Land Office) filed a complaint pursuant to CERCLA seeking damages for injury to natural resources, primarily surface water and coastal wetlands.

Using HEA, the Trustees determined that approximately 28 acres of estuarine marsh habitat would need to be created to compensate for the natural resource injuries and service losses at the site. The Trustees and the PRPs then monetized the settlement by estimating a per acre cost for construction and monitoring of the 28 acres. That total amount served as the basis for the total settlement amount. Through the payment of the settlement amount by the PRPs and the Trustees, a restoration trust fund was established, from which funds would be used by the resource agencies to identify and fund marsh construction.

The settlement monies have been used to create earthen terraces in degraded open water areas for the purposes of establishment of estuarine marsh. The earthen terraces were planted with estuarine emergent vegetation.

The State of Texas v the PRPs for the Col-Tex State Superfund Site; (2001) Colorado City, Texas

This matter relates to the Col -Tex State Superfund Site with AtoFina and Chevron as the two PRPs at this site. The Trustees (Texas Parks and Wildlife Department, TNRCC, and TGLO) sought settlement for damages relating to the release of hazardous substances or petroleum at the former Col-Tex Refinery site, located west of Colorado City, Texas. The Trustees assessed and quantified the potentially injured habitat and potential restoration efforts using the HEA approach.

Approximately 9.3 acres of open water aquatic habitat, 3.6 acres of riverine aquatic habitat, 2.0 acres of riparian habitat and 53.8 acres of terrestrial habitat that was actually or potentially injured at the Col-Tex Refinery Site. Based on HEA, a total of 1.5 acres of open water aquatic habitat (pond construction), 2.4 acres of riverine aquatic/water quality improvement, 21 acres of riparian habitat construction, 25 acres of terrestrial habitat construction and 35 acres of terrestrial habitat placed in conservation in perpetuity was determined to be appropriate compensation for lost services.

As compensation for this injury, Chevron (and AtoFina) developed a restoration plan for the improvement of riverine aquatic habitat and river water quality on Texas Department of Criminal Justice owned property located near the Col Tex Site. These objectives will be accomplished through the implementation of a restoration plan that involves: 1) the restoration of riparian corridor habitat through revegetation, 2) the construction and placement of in-stream engineered erosion control structures, 3) the placement of a conservation easement on the property included in the restoration project area, and 4) the implementation of a vegetative management plan within the existing riparian corridor which includes salt cedar control.

USA and State of Texas v Alcoa; (2001) Point Comfort, Texas

The Point Comfort/Lavaca Bay Site was added to the National Priorities List (NPL) in 1994, primarily due to the levels of mercury found in fish and crabs in Lavaca Bay, a fisheries

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closure imposed by the Texas Department of Health due to mercury levels found in the fish and mercury levels in bay sediments adjacent to the Alcoa facility. The federal and state natural resource Trustees jointly sued Alcoa for injury to natural resources and service in Lavaca Bay associated with the Superfund Site. The Trustees and Alcoa subsequently entered into a Memorandum of Agreement in 1997 to allow for the evaluation of the natural resource injuries and service losses, and to implement restoration activities. The Trustees used HEA to scale the compensatory restoration.

The Trustees determined that appropriate compensatory restoration included: 1) the construction of 61.3 acres of coastal marsh in Powderhorn Lake and Aransas National Wildlife Refuge and 2) the construction of 9.3 acres of oyster reef in Lower Lavaca Bay to compensate for the injury to bay resources.

<u>Commencement Bay Nearshore/Tideflats Superfund Site;</u> (2002) Commencement Bay, Washington (Consent Decree Pending)

In October 1991, the state and federal Trustees (NOAA, USFWS, Bureau of Indian Affairs, Washington Department of Ecology, Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Puyallup Tribe of Indians and the Muckleshoot Indian Tribe) initiated a natural resource damage assessment for the industrial tidalflats and commercial waterways of Commencement Bay. The Trustees determined that the release of hazardous substances into the bay environment had likely injured natural resources. Hazardous substances (copper, lead, mercury, zinc, polycyclic aromatic hydrocarbons, polychlorinated biphenyls and other chlorinated hydrocarbons) were present in detectable concentrations in soft bottom sediments and in tissues of biological receptors.

The Trustees relied on HEA to quantify the restoration activities the PRPs would need to undertake to resolve their natural resource damage liabilities. Performing a HEA on the scale of a large waterway was complex. The analysis consisted of identifying and quantifying the losses in habitat that occurred, identifying the time period and rate at which the losses occurred, and discounting to determine the present value of the total losses. The Trustees analysis of the natural resource injuries that were sustained yielded a total of 2100 DSAYs.

The Trustees goal in this ongoing settlement action is to enter into agreements, resulting in a series of restoration projects that will produce ecological service gains that are equivalent to the calculated service loss of 2100 DSAYs.

Facility Closure /Operation

<u>USA, State of South Dakota and Cheyenne River Sioux Tribe v Homestake Mining;</u> (1999) Deadwood, South Dakota

The United States, the State of South Dakota and the Cheyenne River Sioux Tribe brought natural resource damage claims under CERCLA, the Clean Water Act, and state law, alleging that discharges from the Homestake Mine had contaminated streams, reaching from the Mine down to the Missouri River. Federal, State and Tribal trustees settled the case for \$5.6 million, land and water rights. HEA was used to establish the sufficiency of the settlement.

USA and State of Texas v Chevron; (Consent Decree pending) Port Arthur, Texas

This matter relates to an ongoing NRD claim being jointly asserted by the federal and state NRD Trustees for the former Chevron Refinery in Port Arthur, Texas. Chevron is the primary respondent in this matter. The Trustees have agreed to use HEA methodology to scale the compensatory restoration for injuries to surface water, sediments and coastal marsh habitat.

Physical Damage to Natural Resources

US v Fisher, Salvors Inc.; (1997) Florida Keys, Florida

From January through March 1992, treasure-hunting operations conducted by Salvors, Inc. off Grassy Key, Florida injured 1.6 acres of seagrass. The Trustee (NOAA) sought damages under the National Marine Sanctuaries Act for the lost resources due to the injury.

The most viable off-site compensatory restoration project was to transplant seagrasses into boat-impacted areas that have been designated no-motor zones. Using HEA, NOAA determined that 1.6 acres of seagrass habitat must be restored to compensate for the 44.1 acreyears of lost seagrass services caused by the injuries.

Fisher challenged NOAA's use of HEA and the court ruled that HEA was an appropriate methodology for determining the proper scale of compensatory restoration projects when 1) the primary injury is to ecological/biological function, 2) feasible projects are available that provide service of the same type, quality and comparable values to the affected resources, and 3) sufficient data on the HEA input variable exists and are cost effective to collect.

US v Great Lakes Dredge & Dock Co.; (2001) Florida Keys, Florida

In May 1993, the Florida Keys National Marine Sanctuary suffered natural resource damages caused by a grounded tugboat and a dragging dredge pipe, attributable to contractors hired by Great Lakes Dredge & Dock Company. The grounding of the tugboat destroyed 7,495 square meters of sea bottom, consisting of turtle grass, manatee grass and finger coral. The dragging dredge pipe destroyed 18,280 square meters of sea bottom, consisting primarily of sea grasses.

The Trustees (NOAA and Florida Department of Environmental Protection) sought damages under the National Marine Sanctuaries Act. They used HEA to determine the quantity of habitat needed to compensate for lost interim services due to the injuries. The most viable offsite compensatory restoration project was to transplant seagrass into boat-impacted areas that have been designated no-motor zones. It was determined that 2.2 acres of seagrass habitat be restored in boat impacted areas to compensate for the interim loss of seagrass due to the grounded tugboat and the dredge pipe.

This case originated in the same court as the Fisher case. In the District court, HEA as a scientific methodology underwent a Daubert challenge. Defendants argued that HEA did not meet any of the four criteria for admissibility of scientific testimony; however, the District court Judge disagreed. The 11th Circuit upheld the lower court's ruling that HEA was an acceptable methodology and did fit within the constraints of Daubert. Furthermore, the 11th Circuit upheld the lower court's determination that HEA was an appropriate method for scaling restoration.

USA v Atlas Shipping, LTD; (1999) Florida Keys, Florida

The grounding of the M/V OAXACA (the "Houston") in February 1997 in the Florida Keys National Marine Sanctuary resulted in natural resource injuries, primarily to the coral reefs. The Trustees, NOAA and the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida, concurrently filed a complaint pursuant to the National Marine Sanctuaries Act and state law seeking response costs and damages for the natural resource injuries.

A modified version of the standard HEA showed that the installation of a RACON transponder beacon system would provide sufficient benefits to fully compensate the public for the interim lost revenue pending full recovery of the reef.

The defendants purchased 14 RACON transponder beacons to serve as compensatory restoration. Installation of the RACONs was estimated to prevent approximately 56% of major coral reef groundings in the Sanctuary over the ten-year period following the incident, thereby preventing injury to an estimated 9,900 square meters of coral.

The defendants also funded a ten-year monitoring plan, to be undertaken by the trustees, to assess the biological condition of the injured sanctuary resources and the physical integrity of the restored areas.

Case Law Relating to the Use of Habitat Equivalency Analysis (HEA)

There are two cases in which the validity of HEA has been challenged and ruled upon by the federal courts in the US. These two cases come from the US District Court for the Southern District of Florida (Key West Division) and they are:

<u>US v Fisher</u>; 977 F. Supp. 1193, Decided July 30, 1997 - no appeal

In Fisher, the US District Court for the Southern District of Florida, Key West Division ruled that HEA was an appropriate methodology for determining the proper scale of compensatory restoration projects.

US v Great Lakes Dredge & Dock Co.; 259 F. 3d 1300 (11th Cir. 2001) - Cert. denied

This case originated in the same court as Fisher. In the District court, HEA as a scientific methodology underwent a Daubert challenge. Defendants argued that HEA did not meet any of the four criteria for admissibility of scientific testimony; however, the District court Judge disagreed. The 11th Circuit upheld the lower court's ruling that HEA was an acceptable methodology and did fit within the constraints of Daubert. Furthermore, the 11th Circuit upheld the lower court's determination that HEA was an appropriate method for scaling restoration.

Other Regulatory Areas Using Similar Resource Valuation Methods CWA 316(b) Salem

The Pacific Service Electric and Gas (PSEG) Estuary Enhancement Program (EEP) 11 in the Delaware Estuary is the largest privately funded wetlands restoration program of its kind in the country. The EEP was initiated in 1994, and more than 20,000 acres of degraded salt marsh and uplands along the Delaware Estuary in both New Jersey and Delaware are being restored, enhanced and/or preserved to offset potential effects from plan operations. PSEG is restoring these degraded wetlands to their natural condition (tidal salt marsh) to provide expanded spawning/nursery habitat and food sources needed by fish and other aquatic life. This, in turn, will promote increased productivity of aquatic resources and biodiversity in the estuary.

Agencies that were involved in the NPDES permit application included the New Jersey Department of Environmental Protection (NJDEP), the Delaware Department of Natural Resources (DNREC), and the United States Environmental Protection Agency (USEPA). Other stakeholders included The Nature Conservancy.

Possible effects of plant operations on aquatic organisms include entrainment, impingement and thermal effects. Fish and shellfish are the resources most affected. Standard impact assessment models were used to estimate the reduction in numbers, biomass and/or yield of fish and shellfish species due to entrainment and impingement.

The primary feature of the EEP is the large-scale restoration, enhancement and/or preservation of more than 20,000 acres (32 square miles) of salt marsh and adjacent uplands along the estuary, in both New Jersey and Delaware. This program is providing expanded habitat, shelter, and food for fish and other aquatic species, which in turn helps support increased fish production. The warm, shallow waters of salt marshes and their combination of marsh vegetation, algae and other aquatic organisms give them an extraordinary ability to support fish. Wildlife, endangered and threatened species, and resident and migrating birds also benefit from the expanded habitat. PSEG is restoring sites that have been diked for agricultural or salt hay farming as well as areas that had become dominated by the highly invasive nuisance plant Phragmites australis, known locally as foxtail. The salt marsh restoration/preservation component includes: restoration of tidal flow to three formerly diked areas in New Jersey; Phragmites control on two sites in New Jersey; preservation of unaltered coastal wetlands and uplands in New Jersey; and restoration and/or preservation of degraded wetlands and uplands at several sites in Delaware. The Phragmites control effort also includes one of the most extensive and comprehensive test programs ever conducted for evaluating the effectiveness of various combinations of techniques and approaches for controlling Phragmites. These measures are helping expand habitat for aquatic life while reclaiming a significant amount of wetlands lost from productivity.

Adapted from *Estuary Enhancement Program Fact Sheet: Program Overview*. PSEG. 2002. Accessed July 2002 via World Wide Web:

http://www.pseg.com/companies/nuclear/estuary/introduction/program overview.html.

The EEP also includes an expanded biological monitoring program, one of the most comprehensive ever undertaken for the Delaware Estuary. The data collected will advance knowledge about the estuary and fisheries populations, and enhance regional decision-making regarding use and management of its valuable natural resources. The program includes bay-wide, station and marsh monitoring. Through biological monitoring, PSEG will be able to evaluate the abundance of juvenile fish in the estuary. Similarly, PSEG is using adaptive management, an approach for monitoring, assessing and addressing the progress of restoration, to help identify ways to improve restoration efforts and take steps to ensure marsh restoration success. This effort has become the leading study of biota produced by a restored salt marsh.

The EEP is consistently recognized by its peers, partners and outside organizations as an innovative program that is providing long-term, broad-based benefits for the natural resources and people of the region. Numerous awards and honors have been bestowed upon PSEG for this innovative program. In October 2001, the EEP was awarded a National Oceanic and Atmospheric Administration award for Excellence in Business Leadership for Coastal and Ocean Resource Management.

The EEP is a model for solving complex environmental concerns. By restoring degraded wetlands to provide fish and other aquatic species with expanded habitat and food sources, and addressing concerns about fisheries resources, a true win-win situation results. By allowing PSEG to implement a combination of environmental and technological enhancements which provide long-term ecological benefits, regulators chose an environmentally beneficial alternative to the retrofit of Salem Generating Station with expensive new cooling towers that would have been paid for by consumers. The EEP has become a scientific, social, and environmental success story through broad consultation and unique public/private partnerships. PSEG has worked closely with regulators and decision-makers at the local, county, state, and federal level, scientists, natural resources agencies, environmental groups, community leaders, farmers, sportsmen and watermen. The design of the program and the results to date are the result of many unique partnerships and cooperative efforts. This landmark program is a true demonstration of how public participation, consensus building, public-private partnering and creative thinking can result in win-win solutions for complex environmental and ecological issues, and protection of vital natural resources.

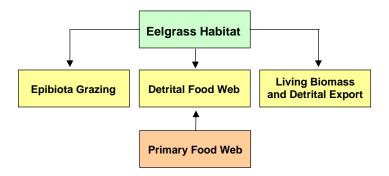
Appendix G: Ecological Benefits and Services Provided By Eelgrass and Coastal Marsh

Eelgrass Habitat

According to the NEP, the total acreage of eelgrass has significantly declined in Morro Bay. In recent years, the number of acres of eelgrass beds have been reported to be less than 50 acres to approximately 90 acres. (NEP 2000, Tenera 2001) The decline appears to be primarily associated with the increase in sedimentation.

Eelgrass (*Zostera marina*) beds residing in Morro Bay are found in the lower intertidal zone in dense stands and are considered critical habitat in the ecosystem. These beds are complex and highly productive systems that serve as a spawning, nursery, and/or forage ground for a variety of fish and invertebrate species. The benthic fauna residing within the eelgrass beds are reported to be several times greater than other Morro Bay habitats in respect to both diversity and density of organisms (NEP, 2000). The enhanced productivity of the aquatic communities sustained by eelgrass beds in Morro Bay is quite characteristic when compared to other eelgrass beds situated within other ecosystems (Thayer 1979, Barnhart 1992, Hanson 1995). Eelgrass habitats support three trophic energy pathways as depicted in Figure 1 below.

Figure 1: Energy Transfer Pathways Associated with Eelgrass Habitat



Although the primary food web is an in situ detrital-based system, the epibiota provides a significant secondary productivity resource. In addition, the adjacent habitats near the eelgrass beds benefit from the export of living biomass and detritus.

Epibiota grazing in the eelgrass habitats, as depicted in Figure 2 below, is represented by both epiphytes (e.g., diatoms, bluegreen algae, bacteria) and epizoites (e.g., protozoans, hydrozoans, bryozoans). The epiphytes are sessile, but a great number of the epizoites are mobile and move on and off the plant. The epibiota provide food for a host of invertebrate grazers including rotifers, isopods, amphipods, polycheates, mysid shrimp, snails and nematodes. The invertebrate grazers become a food resource for mobile macroinvertebrates (e.g., shrimp, crabs, starfish, small squid). Both the invertebrate grazers and the macroinvertebrates become a

food resource for the fish community including small, juvenile and predator fish (Phillips 1984, Thayer 1975).

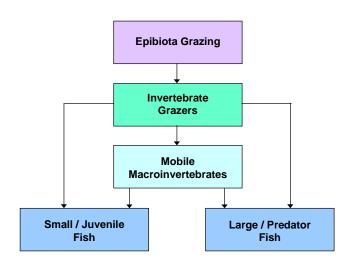


Figure 2: Epibiota Grazing in Eelgrass Habitats

Several investigators have reported that epiphytes can contribute to the total primary production of eelgrass by 18% to 22% (Penhale 1977, Hanson 1995). It has also been reported that at times the epiphyte biomass can equal or exceed the biomass of the eelgrass leaves by as much as 2.3 times (Penhale 1977, Hanson 1995).

Most invertebrate organisms feed only on the detritus produced by eelgrass rather than the living plant. Within this detrital food web there are two major groups of primary consumers, epibenthic fauna and benthic infauna. The epibenthic fauna live on the surface of the sediment and include both sessile and mobile forms. Representative organisms of the epibenthic fauna include shrimp, crabs, harpacticoid copepods, mysids and snails. The benthic infauna are those organisms that live buried in the sediments and include primarily bivalves and polycheates (Thayer 1975, Phillips 1984, Barnhart 1992, Hanson 1995).

The secondary consumers in the eelgrass community are the more mobile organisms referred to as the nekton, which include a variety of macroinvertebrates, small forage fish, juvenile fish and larger fish. The nekton communities can be divided into four groups: 1) permanent residents including gobies and blennies; 2) seasonal residents including many juvenile and subadult stages; 3) transients; and 4) casual species.

Organism Use of Eelgrass Beds

Biological surveys of the aquatic organisms that reside in and utilize Morro Bay eelgrass beds are limited. However, the composition and structure of the eelgrass communities can be predicted with a fairly high level of certainty based on an analysis of the biota that utilize and reside in Morro Bay in conjunction with information reported from surveys of other eelgrass beds along the Pacific Coast.

Eelgrass beds serve as spawning and nursery grounds for many species of fish that reside in and utilize Morro Bay. The topsmelt is considered one of the most abundant fish found in the eelgrass habitat, which also harbors arrow goby (one of the more abundant entrained aquatic organisms), Pacific staghorn sculpin, shiner, perch and bay pipefish, plus other fish species that are less abundant including California halibut, jacksmelt, longjaw mudsucker and snubnose pipefish.

The adult gobies that utilize eelgrass beds are important prey species for a variety of fish species, such as Pacific staghorn sculpin, as well as a source of food for wading or probe-feeding birds (NEP 2000). Pacific herring spawn in the intertidal and subtidal zones and the majority of spawning habitat is within the beds or near vegetation in shallow waters. Pacific herring eggs become prey species for many organisms.

Eelgrass beds can sustain a highly diverse food web encompassing a variety of invertebrates, many kinds of prey and predator fish species, a wide assortment of ducks, geese, and wading birds and mammals.

Very few organisms directly consume fresh eelgrass because of the toughness of the blades, but there are a few bird species (e.g., black brant) that do so and this consumption is mostly on a seasonal basis. Eelgrass beds are important to the black brant for their migration and there is a correlation between the disappearance of eelgrass beds and the reduced abundance of black brant. Morro Bay provides significant eelgrass beds in Central and Southern California and the black brant population is dependent on the continued preservation of this resource (NEP 2000).

Primary Productivity of Eelgrass Beds

Eelgrass beds are highly productive, particularly when considering the cumulative net productivity of the eelgrass and the contributions of the epiphytes, macrophytes and benthic microflora that are prevalent within an eelgrass bed. As previously mentioned, the epiphytes can constitute as much as 18% to 22% of the total production of eelgrass primary productivity.

Table 1 lists net primary productivity rates for eelgrass beds situated on the Pacific coast that have been reported in the literature.

Primary Productivity gm dry weight/m²/yr	Location	Reference		
1,012	Humboldt Bay, CA	Bixler 1982		
530	Humboldt Bay, CA	Harding & Butler 1979		
180 to 1,080	Pacific Coast	Thayer et. Al. 1979		
160 to 960	Puget Sound, WA	Phillips 1972		

Table 1: Net Primary Rates for Eelgrass Habitat

The net primary productivity for eelgrass beds in Humboldt Bay in California ranged from 530 to 1,012 gm dry weight/m²/yr. It should be noted that the productivity value of 1,012 gm dry weight/m²/yr reported by Bixler (1982) is considered a conservative estimate since direct measurements by leaf marking and growth were employed for determining productivity. This type of direct measurement would exclude epiphytes and other sources of carbon production in the overall productivity value.

Coastal Marsh Habitats

Coastal marsh habitats provide a transition zone between terrestrial and aquatic environments. Coastal marsh habitats tend to be shallow water estuarine systems that usually exhibit a low diversity of aquatic organisms, but can support a large number of individuals. Salt marshes provide critical spawning and nursery areas for juvenile fish and shellfish. Salt marshes also provide many services including nesting, cover and foraging habitat for a number of bird species. These habitats play an essential role in erosion control and can significantly aid in reducing the effects of sedimentation. In addition, the export of detritus from decaying vegetation provides an important energy source for the surrounding habitats of the estuary. Salt marshes can also act as a trickling filter for the degradation of organic wastes and the cycling of nutrients. The Morro Bay estuary consists of more than 430 acres of marsh predominantly made up of low salt or high salt marsh, of which 17 plant species have been identified. The low salt marsh is dominated by pickleweed (*Salicornia virginica*) and the high salt marsh is dominated by jaumea (*Jaumeau camosa*). Two other prominent plant species of the tidal salt marshes include alkali heath (*Frankenia salina*) and salt grass (*Distichlis spicata*) (Jarque 1998, NEP, 2000, Tenera 2001).

The primary food webs are detrital-based systems based on the breakdown and decay of the plants by microorganisms and invertebrate detritovores. Both in situ detrital decay and detrital export are involved, but the majority of these systems tend to be net exporters of material out of the marsh. The fate of the products of coastal salt marshes is less predictable than that of eelgrass beds since the inundation of water from tidal flushing over the marsh will vary with the daily and seasonal tidal cycles and the elevation of the marsh. In addition, the intertidal zone of coastal marshes is dependent on the network of channels for movement of resources and access to food (Zedler 1982, Josselyn 1983, Onuf 1987, Greeson 1979, Kirby 1971, Thayer 1978, Barnhart 1992).

Organism Use of Coastal Marsh Habitat

Few fish species use the marsh over their entire life cycle, but for many organisms the coastal marshes serve as a nursery for post larvae and juveniles. These marshes provide protection from predators and ready access to food resources (Zedler 1982, Thayer 1978). At high tide the most prevalent fish species in the Morro Bay salt marshes have been reported to be topsmelt, Pacific staghorn sculpin and arrow goby. An example of a fish species that has adapted to extreme low tidal water conditions of coastal marshes is the longjaw mudsucker (*Gillichthys mirabilis*) that utilizes crab burrows beneath the marsh vegetation and remains in wetted burrows during low tide (Tenera 2001).

Primary Productivity of Coastal Marsh Vegetation

Table 2 lists primary productivity rates for some of the more common or prevalent marsh grasses and mixed species of marsh grasses reported in the literature. In additional to the direct primary production of marsh grasses, epiphytic algal growth on the grasses can add substantially to the total production of marsh vegetation. Primary productivity rates ranging from 100 gm dry weight/m²/yr to more than 4,000 gm dry weight/m²/yr for Atlantic, Pacific and Gulf coastal marshes. The productivity of Southern California marshes, including Tijuana Estuary, Sweetwater River Marsh, San Diego River Marsh, and the Upper Newport Bay Marsh range from 400 to 1,100 gm dry weight/m²/yr with the exception of Mugu Lagoon that reported a productivity range of 100 to 300 gm dry weight/m²/yr. However, it has been noted for the Mugu Lagoon studies that the type of harvest method employed can underestimate productivity by a factor of 2.1 to 3.7 depending on the type of grass species (Zedler 1982, Onuf et. al. 1978). As reported by Zedler (1982), the net annual productivity of marsh vascular plants tends to be below 1,000 gm dry weight/m²/yr for Southern California marshes and they tend to be less reproductive than Atlantic or Gulf marshes. For Humboldt Bay, productivity rates varied from 730 to 1,250 gm dry weight/m²/yr depending on the dominant grass species. NOAA uses a range of 730 to 2,920 for their estimate of West Coast marshes (French, 1996).

For the HEA analysis, a productivity value of 750 gm dry weight/m²/yr was used to estimate acres of eelgrass beds or coastal marsh needed to replace biomass lost from entrainment. This value is considered to be at the low to mid range for California marsh productivity and is therefore considered a conservative estimate of productivity.

Table 2: Primary Productivity Rates for Salt Marsh Habitat

Grass Species	Primary Productivity gm dry weight/m²/yr	Location	Reference	
Spartina dominated	1,250	Humboldt Bay, CA	Bixler 1982	
Spartina alterniflora	360 to 3,600	U.S. Coastal	EPA 1980	
Salicornia & Distichlis	730	Humboldt Bay, CA	Bixler 1982	
Salicornia virginica	1,664	Oregon	EPA 1980	
Salicornia spp.	650 to 2,000	Pacific coast	Thayer 1979	
Distichlis spicata	2,017 to 4,378	U.S. Coastal	EPA 1980	
Distichlis spicata	600 to 1,200	Pacific coast	Thayer 1979	
Spartina foliosa	900	Tijana Estuary, CA	Zedler 1982	
dominated low marsh				
Mixed Species	500 to 700	Tijana Estuary, CA	Zedler 1982	
Middle Elevation				
Mixed Species	400 to 1,000	Tijana Estuary, CA	Zedler 1982	
Upper Elevation				
Mixed Species	700 to 900	Tijana Estuary, CA	Winfield 1980,	
All Elevations			Zedler 1982	
Mixed Species	1,100	Sweetwater River	Eilers 1981,	
All plots combined		Marsh, CA	Zedler 1982	
Salicornia virginica	600	San Diego River	Zedler 1982	
dominant		Marsh, CA		
Mixed Species	600	Upper Newport Bay	Eilers 1981,	
All plots combined		Marsh, CA	Zedler 1982	
Mixed Species	100 to 300	Mugu Lagoon, CA	Onuf et al 1978,	
Low & Middle marsh			Zedler 1982	
Distichlis, Juncus,	560 to 1,200	Atlantic/Gulf Coast	Thayer 1979	
Salicornia			·	
Fringe Wetland and	730-2,920	San Francisco Bay	French, 1996	
Saltmarsh				

Appendix H: HEA References

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Appendix I: PWA Report

See attached report.

Appendix J: PWA Supplemental Report

Appendix K: Use of Consent Decree (Implementation Fund)

Applicant	Project Description	Amount	Total Project Cost	Status	Date of Approval	Actual Payments	6-mo expend projection
Trust for Public Lands	Purchase of 15-acre "Powell" property extending Morro Wetlands Natural Preserve	\$190,175	\$900,000	Complete	Dec, 1999	\$190,175.00	
California Coastal Commission	Match for EPA grant to develop comprehensive GIS for wetlands and riparian areas in watershed	\$35,000	\$460,000	Underway	Jan, 2001	\$25,332.00	
California Conservation Corps	Development of training curriculum for ongoing "watershed crew" to provide labor for restoration work	\$3,000	\$3,000	Completed	Jan, 2001	\$3,000	
Coastal San Luis RCD	Contribution toward funding of a "watershed coordinator" to serve as principal liaison to property owners	\$6,468	\$130,000	In place, ongoing	Jan, 2001	\$5,049.00	\$5,000
Coastal San Luis Resource Conservation District	Pre-engineering for sediment trap, habitat restoration on Los Osos Creek	\$20,000	\$40,000	Underway	Jan, 2001	\$6,893.00	\$10,000
	Appraisal of 580-acre Hollister Ranch on Chorro Creek	\$5,000	\$5,000	Complete	Jan, 2001	\$5,000.00	
Trust for Public Lands	Purchase of 580-acre Hollister Ranch on Chorro Creek for sediment capture, habitat restoration and water "rights"	\$195,000	\$5,800,000	Underway	Dec, 1999		\$195,000
Foundation for Agricultural Awareness (Farm Bureau)	Aerial photography to monitor progress of BMPs instituted on private property	\$2,000	\$10,000	Pending	Jan, 2001		
Gray, Hannah	Research on bio-filtration potential of Pacific Oysters for fecal coliform	\$2,015	\$5,000	Complete	Jan, 2001	\$1,639.00	
Small Wilderness Area Preservation	Aerial photography to monitor Elfin Forest Restoration	\$800	\$10,000	Pending	Jan, 2001		\$800

Applicant	Project Description	Amount	Total Project Cost	Status	Date of Approval	Actual Payments	6-mo expend projection
Army Corps of Engineers	Local match for extensive Local match for extensive in-bay habitat restoration assessment (including eelgrass beds, roosting islands, sediment traps, etc.)	\$801,250	\$1,600,000	Underway	Feb, 2001	\$276,624.00	\$112,000
Morro Bay Beautiful	"Mutt-mitts" dispensers to reduce dog fecal matter around bay	\$5,000	\$8,000	In place, ongoing	April, 2001	\$2,755.00	\$3,000
County of SLO	Stream gauge at Canet Road for National Monitoring Program	\$5,000	\$12,000	Underway	April, 2001		
Trust for Public Lands	Acquisition of "Powell 2", 40- acre site on Los Osos Creek	\$250,000	\$1,600,000	Escrow	April, 2001		\$250,000
Coastal San Luis RCD	"Project Clearwater" providing technical and financial assistance to property owners to reduce pollution	\$81,492	\$422,000	In place, ongoing	April, 2001	\$6750.00	\$7,000
RWQCB	Lab costs for monitoring program	\$14,200	\$79,100	Complete	April, 2001	\$10,992.00	
Small Wilderness Area Preservation	Elfin Forest erosion control and revegetation	\$7,850	\$13,100	Underway	April, 2001	\$2,455.00	\$2,500
	Fire Management Plan	\$50,000	\$50,000	Draft	April, 2001	\$24,500.00	\$10,000
	Catalogue of remediation projects	\$50,000	\$50,000	Draft	April, 2001	\$33,448.00	\$10,000
Coastal San Luis RCD	Steelhead Habitat Assessment	\$22,000	\$66,000	Draft	June, 2001	\$21,777.00	
Williams	Bayshore wetlands Float replacements	\$250,000 \$2,500	\$1,800,000 \$2,500	Complete Pending	July, 2001 July, 2001	\$250,000.00	
Shellfish	- Tout replacements	Ψ2,500	Ψ2,000	1 Griding	July, 2001		
Coastal Resources Inst.	Exotic Plant removal plan	\$5,000	\$13,786	Compete	July, 2001	\$5,000	
Menard & Harbor Department	Vessel and mooring removal	\$3,000	\$3,000	Pending	July, 2001		
UCCE	Microscope	\$1,850	\$9,280	Complete	July 2001	\$1,788.00	
FOE	Computer and printer	\$3,400	\$3,950	Complete	July, 2001	\$1,862.00	
FOE	Boat motor	\$4,900	\$4,900	Underway	July, 2001		\$3,500
SWAP	Elfin Forest Mutt Mitts	\$5,000	\$6,000	In place, ongoing	Oct, 2001	\$2,057.00	\$1,000
Coastal Boatworks	Boat maintenance	\$3,000	\$3,000	Underway	Oct, 2001		

Applicant	Project Description	Amount	Total Project Cost	Status	Date of Approval	Actual Payments	6-mo expend projection
	enclosures						
CSLRCD	Steelhead Pop Survey	\$3,888	\$18,000	Complete	Oct, 2001	\$3,888.00	
CCCs	Watershed crew	\$100,000	\$222,654	In place, ongoing	Oct, 2001	\$19,000.00	\$25,000
County Ag Dept	A. Donax removal	\$25,230	\$111,883	Pending	Oct, 2001		\$15,000
Cal Poly CRI	Exotic Plant removal	\$25,000	\$25,000	Underway	Oct, 2001		\$15,000
MB Harbor	Oil Filter Crusher	\$2,260	\$2,260	Complete	Feb. 2002	\$2,260.00	
Saad & Sanderson	Pre-1850 wetlands map	\$500	\$12,500	Underway	Feb. 2002	\$396.00	
Nelson/Cal Poly	Metals uptake in shellfish	\$4,887	\$4,887	Underway	Feb. 2002		\$4,500
TPL	Hammons (add'l contribution)	\$5,000	\$5,000	Underway	Feb. 2002		\$5,000
FOE	VMP Equipment	\$4,986	\$4,986	Complete	May, 2002		\$4,900
Sustainable Conservation	Permit coordination for restoration projects	\$12,400	\$12,400	Underway	May, 2002		\$12,400
Northwest Hydraulics	GIS interface for erosion projects catalogue	\$8,580	\$8,580	Underway	May, 2002		\$8,000
	ACOE augmentation (public workshop)	\$984	\$984	Complete	May, 2002		
	Fire Management Plan augmentation (public workshop)	\$56	\$56	Complete	May, 2002		
	Hammons archaeology survey	\$400	\$400	Complete	May, 2002		
	Land acquisition costs	\$25,000	\$25,000	In place, ongoing	May, 2002	\$21,935.00	
	Totals	\$2,244,071	\$13,564,206			\$924,575.00	\$699,600
	Less ACOE security+DPR contribution	\$1,944,071	\$13,564,206				

[&]quot;leverage ratio" = 7:1